PATENT SPECIFICATION

(11) 1 569 188

1 569 188

(21) Application No. 47543/76 (22) Filed 15 Nov 1976
(31) Convention Application No. 7513081 (32) Filed 20 Nov 1975 in
(33) Sweden (SE)
(44) Complete Specification Published 11 Jun 1980
(51) INT. CL.^{3} H01F 26/40
(52) Index at Acceptance H1T 12 15 1F 5 7C5

(19)

(54) AN ELECTRICAL TRANSFORMER SYSTEM

(71) We, TRANSMIGRO SCANDINAVIA A.B. of Bjornsongatan 221, S-161, 56 Broma Sweden, a body corporate organized according to the laws of Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electrical transformer which is protected against short circuits.

The usual prior art method for allowing for short circuits is to employ a large unshrouded transformer. When they are short-circuited, such transformers heat up rapidly and can reach an unpermissibly high temperature, due to high energy dissipation in the transformer. Such heating is disadvantageous, but no alternative technical solution to the problem has previously been available.

Other drawbacks of these transformers are, firstly their high volume per unit power ratio and, secondly, the high ratio between their open circuit voltage and rated current voltage. This has resulted in that only transformers for low powers of about 8 VA have been regarded as practicable.

An object of the present invention is to partially or wholly obviate the above mentioned disadvantages.

According to the present invention, there is provided an inherently short-circuit proof electrical transformer system as hereinafter defined including at least one winding, a PTC resistor electrically connected in series with said winding, and a medium including heat conductive material surrounding said PTC resistor and at least a part of said winding, said medium forming a thermal connection between the PTC resistor and the winding and controlling the thermal connection to the PTC resistor.

An inherently short circuit proof electrical transformer system is herein defined as a transformer system in which the temperature rise does not exceed specified limits when the transformer system is overloaded or short circuited and which does not have a device for automatically opening the input circuit or the output circuit when short circuit or overload occurs.

A system may be constructed according to the invention, which has an open field voltage/load voltage ratio which does not differ from that of conventional safety transformers. Furthermore, a considerable reduction of the transformer volume may be obtained with the present invention, so that using the invention, a transformer with a 55 VA capacity can be obtained within the same volume as was previously required for a transformer with a 8 VA capacity.

An embodiment of the present invention will now be described, with reference to the accompanying drawings, wherein:—

Figure 1 is a schematic diagram of a transformer system; and

Figure 2 is a graph comparing the performance of the system of Figure 1 with that of a prior art device.

The system shown in Figure 1 comprises a primary transformer winding 1 and a secondary transformer winding 2. The primary winding 1 is fed with a voltage U_p, whilst a voltage U_s is taken from the secondary winding 2. A positive temperature coefficient resistor 3, whereinafter referred to as a PTC resistor, is connected in series with the transformer secondary winding. The transformer windings as well as the PTC resistor are arranged within the same casing 4 and surrounded by a casting compound 5, of predetermined thermal conductivity coefficient, which fills the casing 4.

When the secondary winding 2 is short-circuited, the PTC resistor 3 is heated by the short-circuit current. Since the resistance of the resistor 3 increases with temperature, the current in the secondary winding 2 decreases, so that heat generation in the transformer

windings is restricted. If there were no thermal connection between the resistor 3 and the rest of the transformer, i.e. if the casting compound 5 were not present, then the duration of the short-circuit current would be mainly determined by the resistor 3. However, since the resistor 3 is situated within the transformer casing 4, a thermal connection exists via the casting compound 5 between the resistor 3 and the transformer. The thermal conductivity of the compound 5 controls the thermal connection to the resistor 3, and thus the current limiting action of the resistor 3.

In the illustrated embodiment, the short-circuit primary current is limited to a value which is less than half of the normal current, as is apparent from Figure 2, in which the curve T_i shows the primary current I_p in the transformer of Figure 1. A current of value I_{rated} is normally fed to the primary side of the transformer. At time t_i a short-circuit occurs, giving rise to a current peak of comparatively short duration. Because of the PTC resistor 3 (Figure 1) the primary current T_i is reduced to less than half of the value I_{rated}. This means that the current is stabilized at a value which does not damage the transformer winding. When the short-circuit is removed, the transformer function returns, either immediately or with a predetermined delay, to the normal current value I_{rated}.

For the purpose of comparison, the corresponding current curve T_k is also shown in Figure 2 for a conventional short-circuit transformer. The short circuit arising at time T_1 is accompanied by a heavy current increase to approximately double the normal current value I_{rated}. As is apparent from the curve T_k, this high short-circuit is maintained as long as the short-circuit is present. A lot of heat is naturally generated in the tranformer windings, which leads to greatly increased temperature, so that damage can occur to the transformer and objects adjacent it.

The embodiment of Figure 1 can be modified in various ways. As has already been mentioned, the thermal connection can be given different thermal conductivities, which affect the appearance of the curve T_i, both with regard to the occurrence of the current peak after the time t_1, and with relation to the slope of the curve before and after the peak value.

In the above described embodiment, the current limiting element is coupled in series with the secondary winding. It could just as well be coupled in series with the primary winding. In transformers with several secondry windings, each of these can be provided with a current limiting element. It is also conceivable for only one or some of the secondary windings to be provided with a series-coupled current limiting element, and the primary winding also to be provided with a current limiting element connected in series.

WHAT WE CLAIM IS:–

1. An inherently short-circuit proof electrical transformer system as hereinbefore defined including at least one winding, a PTC resistor electrically connected in series with said winding, and a medium including heat conductive material surrounding said PTC resistor and at least a part of said winding, said medium forming a thermal connection between the PTC resistor and the winding and controlling the thermal connection to the PTC resistor.

2. An electrical transformer system according to claim 1, wherein said PTC resistor and said winding are situated with a common casing.

3. An electrical transformer system according to claim 1 or claim2, wherein the sensitivity of the PTC resistor is adjustable by means of said heat conductive material added to said medium.

4. An electrical transformer system according to any one of the previous claims, wherein additional windings of said transformer system are each provided with a PTC resistor electrically connected in series with its corresponding winding and thermally connected with at least its corresponding winding.

5. An electrical transformer system substantially as herein described, with reference to and as illustrated in Figure 1 of the accompanying drawing.

MEWBURN ELLIS & CO.,
Chartered Patent Agents,
70-72, Chancery Lane,
London, WC2A 1AD.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by MULTIPLEX techniques ltd., St. Mary Cray, Kent. 1980. Published at the Patent Office, 25 Southampton Buildings, London WC2 1AY, from which copies may be obtained.

1569188 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1

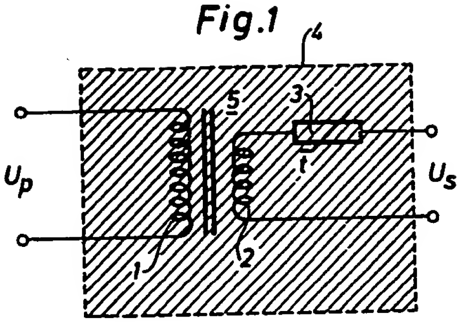

Fig.2